LESSON 7

Monitoring Network Design and Probe-Siting Criteria for SO_2 and PM_{10} SLAMS, NAMS, and PSD Monitoring Stations

Goal

To familiarize you with regulations and guidelines concerning monitoring network design and probe-siting criteria for SO_2 and PM_{10} SLAMS, NAMS, and PSD monitoring stations.

Objectives

At the end of this lesson, you will be able to:

1. recognize the four basic monitoring objectives of SLAMS.
2. associate SLAMS monitoring objectives with spatial scales of representativeness.
3. recognize the primary monitoring objective of NAMS.
4. describe the two basic categories of NAMS.
5. recognize the two primary uses of NAMS data.
6. estimate the number of SO_2 and PM_{10} NAMS required for a given monitoring area.
7. recognize the spatial scale of representativeness required for SO_2 and PM_{10} NAMS.
8. select probe locations for SO_2 and PM_{10} SLAMS, NAMS, and PSD monitoring stations.
9. select the appropriate materials of construction and the sample residence times for SO_2 probes.
10. describe waiver provisions for SLAMS and NAMS probe-siting criteria.
11. select general siting areas for PSD monitoring stations.
12. estimate the number of SO_2 and PM_{10} monitoring stations needed for preconstruction and postconstruction PSD monitoring networks.

13 define ambient air.

14 recognize that PSD monitors should be located in ambient air areas.

15 select appropriate probe heights for SO_2 and PM_{10} PSD monitors used to measure impacts of ground-level sources.

Procedure

1 Read pages 7-4 through 7-23 of this book.

2 Complete the review exercise for this lesson on page 7-24.

3 Check your answers against the answer key following the exercise.

4 Review the pages in the reading for any questions you missed.

5 Take the final examination under the supervision of your test supervisor, according to test directions.

Estimated student completion time: 4 hours

Reading Assignment Topics

- Excerpts of 40 CFR 58 Appendix D (July 1, 1991)
  - SLAMS network design for SO_2 and PM_{10} monitoring stations
  - NAMS network design for SO_2 and PM_{10} monitoring stations
- Excerpts of 40 CFR 58 Appendix E (July 1, 1991)
  - Probe-siting criteria for SO_2 SLAMS and NAMS
  - Probe-siting criteria for PM_{10} SLAMS and NAMS
  - Materials of construction and maximum sample residence time for SO_2 probes
  - Waiver provisions for SLAMS and NAMS probe-siting criteria
- Excerpts of "Ambient Monitoring Guidelines for Prevention of Significant Deterioration (PSD)" (EPA-450/4-87-007)
  - Network design for PSD monitoring stations
  - Probe-siting criteria for ground-level sources

Reading Guidance

SLAMS and NAMS are required for State Implementation Plan ambient air quality monitoring networks. The information concerning SLAMS and NAMS contained in the assigned reading material is stated as a regulation.

PSD monitoring stations are used to determine the air quality impacts of existing or proposed sources that are located in areas meeting the National Ambient Air Quality Standards (NAAQS). The information concerning PSD monitoring stations contained in the assigned reading material is stated as a guideline.

The probe-siting criteria for SO_2 and PM_{10} PSD monitoring stations are identical to the probe-siting criteria for SO_2 and PM_{10} SLAMS and NAMS.

PM_{10} sampler setback distances described in the assigned reading materials apply only to *paved* roadways.

Excerpts of 40 CFR 58 Appendices D and E

Appendix D-Network Design for State and Local Air Monitoring Stations (SLAMS) and National Air Monitoring Stations (NAMS)

1. SLAMS Monitoring Objectives and Spatial Scales

The purpose of this appendix is to describe monitoring objectives and general criteria to be applied in establishing the State and Local Air Monitoring Stations (SLAMS) networks and for choosing general locations for new monitoring stations. It also describes criteria for determining the number and location of National Air Monitoring Stations (NAMS). These criteria will also be used by EPA in evaluating the adequacy of SLAMS/NAMS networks.

The network of stations which comprise SLAMS should be designed to meet a minimum of four basic monitoring objectives. These basic monitoring objectives are: (1) To determine highest concentrations expected to occur in the area covered by the network; (2) to determine representative concentrations in areas of high population density; (3) to determine the impact on ambient pollution levels of significant sources or source categories; and (4) to determine general background concentration levels.

To a large extent, the existing State Implementation Plan (SIP) monitoring networks have been designed with these four objectives in mind. Thus, they can serve as the logical starting point for establishing the SLAMS network. This will, however, require a careful review of each existing SIP ambient network to determine the principal objectives of each station and the extent to which the location criteria presented herein are being met. It should be noted that this appendix contains no criteria for determining the total number of stations in SLAMS networks, except that a minimum number of lead SLAMS is prescribed. The optimum size of a particular SLAMS network involves trade offs among data needs and available resources which EPA believes can best be resolved during the network design process.

This appendix focuses on the relationship between monitoring objectives and the geographical location of monitoring stations. Included are a rationale and set of general criteria for identifying candidate station locations in terms of physical characteristics which most closely match a specific monitoring objective. The criteria for more specifically siting the monitoring station including spacing from roadways and vertical and horizontal probe placement, are described in appendix E of this part.

To clarify the nature of the link between general monitoring objectives and the physical location of a particular monitoring station, the concept of spatial scale of representativeness of a monitoring station is defined. The goal in siting stations is to correctly match the spatial scale represented by the sample of monitored air with the spatial scale most appropriate for the monitoring objective of the station.

Thus, spatial scale of representativeness is described in terms of the physical dimensions of the air parcel nearest to a monitoring station throughout which actual pollutant concentrations are reasonably similar. The scale of representativeness of most interest for the monitoring objectives defined above are as follows:

Microscale—defines the concentrations in air volumes associated with area dimensions ranging from several meters up to about 100 meters.

Middle Scale—defines the concentration typical of areas up to several city blocks in size with dimensions ranging from about 100 meters to 0.5 kilometer.

Neighborhood Scale—defines concentrations within some extended area of the city that has relatively uniform land use with dimensions in the 0.5 to 4.0 kilometers range.

Urban Scale—defines the overall, citywide conditions with dimensions on the order of 4 to 50 kilometers. This scale would usually require more than one site for definition.

Regional Scale—defines usually a rural area of reasonably homogeneous geography and extends from tens to hundreds of kilometers.

National and Global Scales—these measurement scales represent concentrations characterizing the nation and the globe as a whole.

Proper siting of a monitoring station requires precise specification of the monitoring objective which usually includes a desired spatial scale of representativeness. For example, consider the case where the objective is to determine maximum CO concentrations in areas where pedestrians may reasonably be exposed. Such areas would most likely be located within major street canyons of large urban areas and near traffic corridors. Stations located in these areas are most likely to have a microscale of representativeness since CO concentrations typically peak nearest roadways and decrease rapidly as the monitor is moved from the roadway. In this example, physical location was determined by consideration of CO emission patterns, pedestrian activity, and physical characteristics affecting pollutant dispersion. Thus, spatial scale of representativeness was not used in the selection process but was a *result* of station location.

In some cases, the physical location of a station is determined from joint consideration of both the basic monitoring objective, and a desired spatial scale of representativeness. For example, to determine CO concentrations which are typical over a reasonably broad geographic area having relatively high CO concentrations, a neighborhood scale station is more appropriate. Such a station would likely be located in a residential or commercial area having a high overall CO emission density but not in the immediate vicinity of any single roadway. Note that in this example, the desired scale of representativeness was an important factor in determining the physical location of the monitoring station.

In either case, classification of the station by its intended objective and spatial scale of representativeness is necessary and will aid in interpretation of the monitoring data.

Table 1 illustrates the relationship between the four basic monitoring objectives and the scales of representativeness that are generally most appropriate for that objective.

Table 1—Relationship Among Monitoring Objectives and Scale of Representativeness

Monitoring objective	Appropriate siting scales
Highest concentration....	Micro, middle, neighborhood (some-times urban).
Population.....................	Neighborhood, urban.
Source impact...............	Micro, middle, neighborhood.
General/background......	Neighborhood, regional.

Subsequent sections of this appendix describe in greater detail the most appropriate scales of representativeness and general monitoring locations for each pollutant.

2. *SLAMS Network Design Procedures*

The preceding section of this appendix has stressed the importance of defining the objectives for monitoring a particular pollutant. Since monitoring data are collected to "represent" the conditions in a section or subregion of a geographical area, the previous section included a discussion of the scale of representativeness of a monitoring station. The use of this physical basis for locating stations allows for an objective approach to network design.

The discussion of scales in sections 2.2-2.6 does not include all of the possible scales for each pollutant. The scales which are discussed are those which are felt to be most pertinent for SLAMS network design.

In order to evaluate a monitoring network and to determine the adequacy of particular monitoring stations, it is necessary to examine each pollutant monitoring station individually by stating its monitoring objective and determining its spatial scale of representativeness. This will do more than insure compatibility among stations of the same type. It will also provide a physical basis for the interpretation and application of the data. This will help to prevent mismatches between what the data actually represent and what the data are interpreted to represent. It is important to note that SLAMS are not necessarily sufficient for completely describing air quality. In many situations, diffusion models must be applied to complement ambient monitoring, e.g., determining the impact of point sources or defining boundaries of nonattainment areas.

2.1 Background Information for Establishing SLAMS

Background information that must be considered in the process of selecting SLAMS from the existing network and in establishing new SLAMS includes emission inventories, climatological summaries, and local geographical characteristics. Such information is to be used as a basis for the judgmental decisions that are required during the station selection process. For new stations, the background information should be used to decide on the actual location considering the monitoring objective and spatial scale while following the detailed procedures in References 1 through 4.

Emission inventories are generally the most important type of background information needed to design the SLAMS network. The emission data provide valuable information concerning the size and distribution of large point sources. Area source emissions are usually available for counties but should be subdivided into smaller areas or grids where possible, especially if diffusion modeling is to be used as a basis for determining where stations should be located. Sometimes this must be done rather crudely, for example, on the basis of population or housing units. In general, the grids should be smaller in areas of dense population than in less densely populated regions.

Emission inventory information for point sources should be generally available for any area of the country for annual and seasonal averaging times. Specific information characterizing the emissions from large point sources for the shorter averaging times (diurnal variations, load curves, etc.) can often be obtained from the source. Area source emission data by season, although not available from the EPA, can be generated by apportioning annual totals according to degree days.

Detailed area source data are also valuable in evaluating the adequacy of an existing station in terms of whether the station has been located in the desired spatial scale of representativeness. For example, it may be the desire of an agency to have an existing CO station measuring in the neighborhood scale.

By examining the traffic data for the area and examining the physical location of the station with respect to the roadways, a determination can be made as to whether or not the station is indeed measuring the air quality on the desired scale.

The climatological summaries of greatest use are the frequency distributions of wind speed and direction. The wind rose is an easily interpreted graphical presentation of the directional frequencies. Other types of useful climatological data are also available, but generally are not as directly applicable to the site selection process as are the wind statistics.

In many cases, the meteorological data originating from the most appropriate (not necessarily the nearest) national weather service (NWS) airport station in the vicinity of the prospective siting area will adequately reflect conditions over the area of interest, at least for annual and seasonal averaging times. In developing data in complex meteorological and terrain situations, diffusion meteorologists should be consulted. NWS stations can usually provide most of the relevant weather information in support of network design activities anywhere in the country. Such information includes joint frequency distributions of winds and atmospheric stability (stability-wind roses).

The geographical material is used to determine the distribution of natural features, such as forests, rivers, lakes, and manmade features. Useful sources of such information may include road and topographical maps, aerial photographs, and even satellite photographs. This information may include the terrain and land-use setting of the prospective monitor siting area, the proximity of larger water bodies, the distribution of pollutant sources in the area, the location of NWS airport stations from which weather data may be obtained, etc. Land use and topographical characteristics of specific areas of interest can be determined from U.S. Geological Survey (USGS) maps and land use maps. Detailed information on urban physiography (building/street dimensions, etc.) can be obtained by visual observations, aerial photography, and also surveys to supplement the information available from those sources. Such information could be used in determining the location of local pollutant sources in and around the prospective station locations.

2.2 [Reserved]

2.3 Sulfur Dioxide (SO_2) Design Criteria for SLAMS

The spatial scales for SO_2 SLAMS monitoring are the middle, neighborhood, urban, and regional scales. Because of the nature of SO_2 distributions over urban areas, the middle scale is the most likely scale to be represented by a single measurement in an urban area, but only if the undue effects from local sources (minor or major point sources) can be eliminated. Neighborhood scales would be those most likely to be represented by single measurements in suburban areas where the concentration gradients are less steep. Urban scales would represent areas where the concentrations are uniform over a larger geographical area. Regional scale measurements would be associated with rural areas.

Middle Scale—Some data uses associated with middle scale measurements for SO_2 include assessing the effects of control strategies to reduce urban concentrations (especially for the 3-hour and 24-hour averaging times) and monitoring air pollution episodes.

Neighborhood Scale—This scale applies in areas where the SO_2 concentration gradient is relatively flat (mainly suburban areas surrounding the urban center) or in large sections of small cities and towns. In general, these areas are quite homogeneous in terms of SO_2 emission rates and population density. Thus, neighborhood scale measurements may be associated with baseline concentrations in areas of projected growth and in studies of population responses to exposure to SO_2. Also concentration maxima associated with air pollution episodes may be uniformly distributed over areas of neighborhood scale, and measurements taken within such an area would represent neighborhood, and to a limited extent, middle scale concentrations.

Urban Scale—Data from this scale could be used for the assessment of air quality trends and the effect of control strategies on urban scale air quality.

Regional Scale—These measurements would be applicable to large homogeneous areas, particularly those which are sparsely populated. Such measurements could provide information on background air quality and interregional pollutant transport.

After the spatial scale has been selected to meet the monitoring objectives for each station location, the procedures found in reference 2 should be used to evaluate the adequacy of each existing SO_2 station and must be used to relocate an existing station or to locate any new SLAMS stations. The background material for these procedures should consist of emission inventories, meteorological data, wind roses, and maps for population and topographical characteristics of specific areas of interest. Isopleth maps of SO_2 air quality as generated by diffusion models[5] are useful for the general determination of a prospective area within which the station is eventually placed.

★ ★ ★ ★ ★ ★

2.8 *PM_{10} Design Criteria for SLAMS*

As with other pollutants measured in the SLAMS network, the first step in designing the PM_{10} network is to collect the necessary background information. Various studies[11,12,13,14,15,16] have documented the major source categories of particulate matter and their contribution to ambient levels in various locations throughout the country. Because the sources for PM_{10} are similar to those for TSP, the procedures for collecting the necessary background information for PM_{10} are also similar. Sources of background information would be regional and traffic maps and aerial photographs showing topography, settlements, major industries and highways. These maps and photographs would be used to identify areas of the type that are of concern to the particular monitoring objective. After potentially suitable monitoring areas for PM_{10} have been identified on a map, modeling may be used to provide an estimate of PM_{10} concentrations throughout the area of interest. After completing the first step, existing TSP SLAMS or other particulate matter stations should be evaluated to determine their potential as candidates for SLAMS designation. Stations meeting one or more of the four basic monitoring objectives described in section 1 of this appendix must be classified into one of the five scales of representativeness (micro, middle, neighborhood, urban and regional) if the stations are to become SLAMS. In siting and classifying PM_{10} stations, the procedures in reference 17 should be used.

If existing TSP samplers meet the quality assurance requirements of appendix A, the PM_{10} siting requirements of appendix E, and are located in areas of suspected maximum concentrations are described in section 3 of appendix D, and if the TSP levels are below the ambient PM_{10} standards, TSP samplers may continue to be used as substitutes for PM_{10} SLAMS samplers under the provisions of section 2.2 of appendix C.

The most important spatial scales to effectively characterize the emissions of PM_{10} from both mobile and stationary sources are the micro, middle and neighborhood scales. For purposes of establishing monitoring stations to represent large homogenous areas other than the above scales of representativeness, urban or regional scale stations would also be needed.

Microscale—This scale would typify areas such as downtown street canyons and traffic corridors where the general public would be exposed to maximum concentrations from mobile sources. Because of the very steep ambient PM_{10} gradients resulting from mobile sources, the dimensions of the microscale for PM_{10} generally would not extend beyond 15 meters from the roadway, but could continue the length of the roadway which could be several kilometers. Microscale PM_{10} sites should be located near inhabited buildings or locations where the general public can be expected to be exposed to the concentration measured. Emissions from stationary sources such as primary and secondary smelters, power plants, and other large industrial processes may, under certain plume conditions, likewise result in high ground level concentrations at the microscale. In the latter case, the microscale would represent an area impacted by the plume with dimensions extending up to approximately 100 meters. Data collected at microscale stations provide information for evaluating and developing "hotspot" control measures.

Middle Scale—Much of the measurement of short-term public exposure to PM_{10} is on this scale. People moving through downtown areas, or living near major roadways, encounter particles that would be adequately characterized by measurements of this spatial scale. Thus, measurements of this type would be appropriate for the evaluation of possible short-term public health effects of particulate matter pollution. This scale also includes the characteristic concentrations for other areas with dimensions of a few hundred meters such as the parking lot and feeder streets associated with shopping centers, stadia, and office buildings. In the case of PM_{10}, unpaved or seldom swept parking lots associated with these sources could be an important source in addition to the vehicular emissions themselves.

Neighborhood Scale—Measurements in this category would represent conditions throughout some reasonably homogeneous urban subregion with dimensions of a few kilometers and of generally more regular shape than the middle scale. Homogeneity refers to the PM_{10} concentrations, as well as the land use and land surface characteristics. In some cases, a location carefully chosen to provide neighborhood scale data would represent not only the immediate neighborhood but also neighborhoods of the same type in other parts of the city. Stations of this kind provide good information about trends and compliance with standards because they often represent conditions in areas where people commonly live and work for periods comparable to those specified in the NAAQS. This category also includes industrial and commercial neighborhoods, as well as residential.

Neighborhood scale data could provide valuable information for developing, testing, and revising models that describe the larger-scale concentration patterns, especially those models relying on spatially smoothed emission fields for inputs. The neighborhood scale measurements could also be used for neighborhood comparisons within or between cities. This is the most likely scale of measurements to meet the needs of planners.

Urban Scale—This class of measurement would be made to characterize the PM_{10} concentration over an entire metropolitan area. Such measurements would be useful for assessing trends in city-wide air quality, and hence, the effectiveness of large scale air pollution control strategies.

Regional Scale—These measurements would characterize conditions over areas with dimensions of as much as hundreds of kilometers. As noted earlier, using representative conditions for an area implies some degree of homogeneity in that area. For this reason, regional scale measurements would be most applicable to sparsely populated areas with reasonably uniform ground cover. Data characteristics of this scale would provide information about larger scale processes of PM_{10} emissions, losses and transport.

3. *Network Design for National Air Monitoring Stations (NAMS)*

The NAMS must be stations selected from the SLAMS network with emphasis given to urban and multisource areas. Areas to be monitored must be selected based on urbanized population and pollutant concentration levels. Generally, a larger number of NAMS are needed in more polluted urban and multisource areas. The network design criteria discussed below reflect these concepts. However, it should be emphasized that deviations from the NAMS network design criteria may be necessary in a few cases. Thus, these design criteria are not a set of rigid rules but rather a guide for achieving a proper distribution of monitoring sites on a national scale.

The primary objective for NAMS is to monitor in the areas where the pollutant concentration and the population exposure are expected to be the highest consistent with the averaging time of the NAAQS. Accordingly, the NAMS fall into two categories:

Category (a): Stations located in area(s) of expected maximum concentrations (generally microscale for CO, microscale or middle scale for Pb and PM_{10}, neighborhood scale for SO_2, and NO_2, and urban scale for O_3.

Category (b): Stations which combine poor air quality with a high population density but not necessarily located in an area of expected maximum concentrations (neighborhood scale, except urban scale for NO_2). Category (b) monitors would generally be representative of larger spatial scales than category (a) monitors.

For each urban area where NAMS are required, both categories of monitoring stations must be established. In the case of TSP and SO_2 if only one NAMS is needed, then category (a) must be used. The analysis and interpretation of data from NAMS should consider the distinction between these types of stations as appropriate.

The concept of NAMS is designed to provide data for national policy analyses/trends and for reporting to the public on major metropolitan areas. It is not the intent to monitor in every area where the NAAQS are violated. On the other hand, the data from SLAMS should be used primarily for nonattainment decisions/analyses in specific geographical areas. Since the NAMS are stations from the SLAMS network, station locating procedures for NAMS are part of the SLAMS network design process.

3.1 [Reserved]

3.2 Sulfur Dioxide (SO_2) Design Criteria for NAMS

It is desirable to have a greater number of NAMS in the more polluted and densely populated urban and multisource areas. The data in Table 3 show the approximate number of permanent stations needed in urban areas to characterize the national and regional SO_2 air quality trends and geographical patterns. These criteria require that the number of NAMS in areas where urban populations exceed 1,000,000 and concentrations also exceed the primary NAAQS may range from 6 to 10 and that in areas where the SO_2 problem is minor, only one or two (or no) monitors are required. For those cases where more than one station is required for an urban area, there should be at least one station for category (a) and category (b) objectives as discussed in section 3. Where three or more stations are required, the mix of category (a) and (b) stations is determined on a case-by-case basis. The actual number and location of the NAMS must be determined by EPA Regional Offices and the State agency, subject to the approval of EPA Headquarters (OANR).

Table 3—SO_2 National Air Monitoring Station Criteria

[Approximate number of stations per area][a]

Population category	High concentration[b]	Medium concentration[c]	Low concentration[d]
>1,000,000	6-10	4-8	2-4
500,000 to 1,000,000	4-8	2-4	1-2
250,000 to 500,000	3-4	1-2	0-1
100,000 to 250,000	1-2	0-1	0

[a] Selection of urban areas and actual number of stations per area will be jointly determined by EPA and the State agency.

[b] High concentration-exceeding level of the primary NAAQS.

[c] Medium concentration-exceeding 60 percent of the level of the primary or 100% of the secondary NAAQS.

[d] Low concentration-less than 60 percent of the level of the primary or 100% of the secondary NAAQS.

The estimated number of SO_2 NAMS which would be required nationwide ranges from approximately 200 to 300. This number of NAMS SO_2 monitors is sufficient for national trend purposes due to the low background SO_2 levels, and the fact that air quality is very sensitive to SO_2 emission changes. The actual number of stations in any specific area depends on local factors such as meteorology, topography, urban and regional air quality gradients, and the potential for significant air quality improvements or degradation. The greatest density of stations should be where urban populations are large and where pollution levels are high. Fewer NAMS are necessary in the western States since concentrations are seldom above the NAAQS in their urban areas. Exceptions to this are in the areas where an expected shortage of clean fuels indicates that ambient air quality may be degraded by increased SO_2 emissions. In such cases, a minimum number of NAMS is required to provide EPA with a proper national perspective on significant changes in air quality.

Like TSP, the worst air quality in an urban area is to be used as the basis for determining the required number of SO_2 NAMS (see Table 3). This includes SO_2 air quality levels within populated parts of urbanized areas, that are affected by one or two point sources of SO_2 if the impact of the source(s) extends over a reasonably broad geographic scale (neighborhood or larger). Maximum SO_2 air quality levels in remote unpopulated areas should be excluded as a basis for selecting NAMS regardless of the sources affecting the concentration levels. Such remote areas are more appropriately monitored by SLAMS or SPM networks and/or characterized by diffusion model calculations as necessary.

★ ★ ★ ★ ★ ★

3.7 PM_{10}, Design Criteria for NAMS

Table 4 indicates the approximate number of permanent stations required in urban areas to characterize national and regional PM_{10} air quality trends and geographical patterns. The number of stations in areas where urban populations exceed 1,000,000 must be in the range from 2 to 10 stations, while in low population urban areas, no more than two stations are required. A range of monitoring stations is specified in Table 4 because sources of pollutants and local control efforts can vary from one part of the country to another and therefore, some flexibility is allowed in selecting the actual number of stations in any one locale.

It is recognized that no PM_{10} samplers will be designated as PM_{10} reference or equivalent methods until, at the earliest, approximately six months after promulgation of PM_{10} NAAQS and the reference and equivalent method requirements. Even though non-designated PM_{10} samplers will have been commercially available, and a small number of samplers will have been in use by EPA, other agencies, and industry, there will not be enough ambient PM_{10} data to determine ambient PM_{10} levels for all areas of the country. Accordingly, EPA has provided guidance[18] on converting ambient IP_{15} data to ambient PM_{10} data. Ambient IP_{15} data are data from high volume samplers utilizing quartz filters or dichotomous samplers, both with inlets designed to collect particles nominally 15 um and below. Also included in the guidance are procedures for calculating from ambient TSP data the probability that an area will be nonattainment for PM_{10}. For determining the appropriate number of NAMS per area, the converted IP_{15} data or the probabilities of PM_{10} nonattainment are used in Table 4, unless ambient PM_{10} data are available. If only one monitor is required in an urbanized area, it must be a category (a) type. Since emissions associated with the operation of motor vehicles contribute to urban area particulate matter levels, consideration of the impact of these sources must be included in the design of the NAMS network, particularly in urban areas greater than 500,000 population. In certain urban areas particulate emissions from motor vehicle diesel exhaust currently is or is expected to be a significant source of PM_{10} ambient levels. If an evaluation of the sources of PM_{10} as described in section 2.8 indicates that the maximum concentration area is predominantly influenced by roadway emissions, then the category (a) station should be located adjacent to a major road and should be a microscale or middle scale. A microscale is preferable but a middle scale is also acceptable if a suitable microscale location cannot be found. However, if the predominant influence in the suspected maximum concentration area is expected to be industrial emissions, and/or combustion products (from other than an isolated single source), the category (a) station should be a middle scale or neighborhood scale. A middle scale exposure is preferable to a neighborhood scale in representing the maximum concentration impact from multiple sources, other than vehicular, but a neighborhood scale is acceptable, especially in large residential areas that burn oil, wood, and/ or coal for space heating.

For those cases where more than one station is required for an urban area, there should be at least one station for category (a) and one station for category (b) neighborhood scale objectives as discussed in section 3. Where three or more stations are required, the mix of category (a) and (b) stations is to be determined on a case-by-case basis. The actual number of NAMS and their locations must be determined by EPA Regional Offices and the State agencies, subject to the approval of the Administrator as required by §58.32. The Administrator's approval is necessary to insure that individual stations conform to the NAMS selection criteria and that the network as a whole is sufficient in terms of number and location for purposes of national analyses. As required under the provisions of section 2.2 of appendix C, all PM_{10} NAMS that were previously designated as TSP NAMS must concurrently collect ambient TSP and PM_{10} data for a one-year period beginning when each NAMS PM_{10} sampler is put into operation.

Table 4—PM10 National Air Monitoring Station Criteria
[Approximate Number of Stations per Area][a]

Population category	High concentration[b] [e]	Medium concentration[c] [e]	Low concentration[d] [e]
>1,000,000	6-10	4-8	2-4
500,000-1,000,000	4-8	2-4	1-2
250,000-500,000	3-4	1-2	0-1
100,000-250,000	1-2	0-1	0

[a] Selection of urban areas and actual number of stations per area will be jointly determined by EPA and the State agency.
[b] High concentration areas are those for which: Ambient PM_{10} data or ambient IP_{15} data converted to PM_{10} show ambient concentrations exceeding either PM_{10} NAAQS by 20 percent or more; or the probability of PM_{10} nonattainment, calculated from TSP data, is 95 percent or greater.
[c] Medium concentration areas are those for which: Ambient PM_{10} data or ambient IP_{15} data converted to PM_{10} show ambient concentrations exceeding either 80 percent of the PM_{10} NAAQS, or the probability of PM_{10} nonattainment, calculated from TSP data, is $\geq$20 percent and <95 percent.
[d] Low concentration areas are those for which: Ambient PM_{10} data or ambient IP_{15} data converted to PM_{10} show ambient concentrations less than 80 percent of the PM_{10} NAAQS; or the probability of PM_{10} nonattainment, calculated from TSP data, is less than 20 percent.
[e] Procedures for estimating ambient PM_{10} concentrations from IP_{15} ambient air measurements or for estimating the probability of nonattainment for PM_{10} given observed TSP data are provided in reference 18.

4. *Summary*

Table 5 shows by pollutant, all of the spatial scales that are applicable for SLAMS and the required spatial scales for NAMS. There may also be some situations, as discussed later in appendix E, where additional scales may be allowed for NAMS purposes.

5. *References*

1. Ludwig, F. L., J. H. S. Kealoha, and E. Shelar. Selecting Sites for Monitoring Total Suspended Particulates. Stanford Research Institute, Menlo Park, CA. Prepared for U.S. Environmental Protection Agency, Research Triangle Park, NC. EPA Publication No. EPA-450/3-77-018. June 1977, revised December 1977.

Table 5—Summary of Spatial Scales for SLAMS and Required Scales for NAMS

Spatial	Scale Applicable for SLAMS						Scales Required for NAMS					
	SO_2	CO	O_3	NO_2	Pb	PM_{10}	SO_2	CO	O_3	NO_2	Pb	PM_{10}
Micro		✓			✓	✓		✓			✓	✓
Middle	✓	✓	✓	✓	✓	✓					✓	✓
Neighborhood	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Urban	✓		✓	✓	✓	✓			✓	✓		
Regional	✓		✓		✓	✓						

2. Ball, R. J. and G. E. Anderson. Optimum Site Exposure Criteria for SO_2 Monitoring. The Center for the Environment and Man, Inc., Hartford, CT. Prepared for U.S. Environmental Protection Agency, Research Triangle Park, NC. EPA Publication No. EPA-450/3-77-013. April 1977.

3. Ludwig, F. L. and J. H. S. Kealoha. Selecting Sites for Carbon Monoxide Monitoring. Stanford Research Institute, Menlo Park, CA. Prepared for U.S. Environmental Protection Agency, Research Triangle Park, NC. EPA Publication No. EPA-450/3-75-077. September 1975.

4. Ludwig, F. L. and E. Shelar. Site Selecting for the Monitoring of Photochemical Air Pollutants. Stanford Research Institute, Menlo Park, CA. Prepared for U.S. Environmental Protection Agency, Research Triangle Park, NC. EPA Publication No. EPA-450/3-78-013. April 1978.

5. Guideline on Air Quality Models. OAQPS, U.S. Environmental Protection Agency, Research Triangle Park, NC. OAQPS No. 1.2-080. April 1978.

6. Control Techniques for Lead Air Emissions, OAQPS, U.S. Environmental Protection Agency, Research Triangle Park, NC. EPA-450/2-77-012. December 1977.

7. Air Quality Criteria for Lead. Office of Research and Development, U.S. Environmental Protection Agency, Washington, DC. EPA-600/8-77-017. December 1977.

8. Johnson, D. E., et al. Epidemiologic Study of the Effects of Automobile Traffic on Blood Lead Levels, Southwest Research Institute, Houston, TX. Prepared for U.S. Environmental Protection Agency, Research Triangle Park, NC. EPA-600/1-78-055. August 1978.

9. Optimum Site Exposure Criteria for Lead Monitoring. PEDCo Environmental, Inc., Cincinnati, OH. Prepared for U.S. Environmental Protection Agency, Research Triangle Park, NC. EPA Contract No. 68-02-3013. (May 1981.)

10. Guidance for Lead Monitoring in the Vicinity of Point Sources. Office of Air Quality Planning and Standards, and Environmental Monitoring Systems Laboratory, U.S. Environmental Protection Agency, Research Triangle Park, NC. EPA-450/4-81-006. January 1981.

11. Cooper, J.A., et. al. Summary of the Portland Aerosol Characterization Study. (Presented at the 1979 Annual Air Pollution Association Meeting, Cincinnati, OH. APCA 79-24.4).

12. Bradway, R.M. and F.A. Record. National Assessment of the Urban Particulate Problem. Volume 1. Prepared for U.S. Environmental Protection Agency, Research Triangle Park, NC. EPA-450/3-76-024. July 1976.

13. U.S. Environmental Protection Agency, Air Quality Criteria for Particulate Matter and Sulfur Oxides, Volume 2. Environmental Criteria and Assessment Office, Research Triangle Park, NC. December 1981.

14. Watson, J.G., et al. Analysis of Inhalable and Fine Particulate Matter Measurements. Prepared for U.S. Environmental Protection Agency, Research Triangle Park, NC. EPA-450/4-81-035. December 1981.

15. Record, F.A. and L.A. Baci. Evaluation on Contribution of Wind Blown Dust from the Desert Levels of Particulate Matter in Desert Communities. GCA Technology Division, Bedford, MA. Prepared for U.S. Environmental Protection Agency, Research Triangle Park, NC. EPA-450/2-80-078. August 1980.

16. Goldstein, E.A. and Paly M. The Diesel Problem in New York City. Project on the Urban Environment. Natural Resources Defense Council, Inc., New York, NY. April 1985.

17. Koch, R.C. and H.E. Rector. Optimum Network Design and Site Exposure Criteria for Particulate Matter. GEOMET Technologies, Inc., Rockville, MD. Prepared for U.S. Environmental Protection Agency, Research Triangle Park, NC. EPA Contract No. 68-02-3584. EPA 450/4-87-009. May 1987.

18. Pace, T., et al. Procedures for Estimating Probability of Nonattainment of a PM_{10} Data. U.S. Environmental Protection Agency, Research Triangle Park, NC. EPA-450/4-86-017. December 1986.

[44 FR 27571, May 10, 1979; 44 FR 72592, Dec. 14, 1979, as amended at 46 FR 44168, Sept. 3, 1981; 51 FR 9597, Mar. 19, 1986; 52 FR 24742-23744, July 1, 1987; 52 FR 27286, July 20, 1987; 54 FR 15183, Apr. 17, 1989]

Appendix E—Probe Siting Criteria for Ambient Air Quality Monitoring

1. Introduction

2. [Reserved]

3. Sulfur Dioxide (SO_2)

3.1 Horizontal and Vertical Probe Placement

3.2 Spacing from Obstructions

3.3 Spacing from trees and other considerations.

4. Carbon Monoxide (CO)

4.1 Horizontal and Vertical Probe Placement

4.2 Spacing from Obstructions

4.3 Spacing from Roads

4.4 Spacing from trees and other considerations.

5. Ozone (O_3)

5.1 Vertical and Horizontal Probe Placement

5.2 Spacing from Obstructions

5.3 Spacing from Roads

5.4 Spacing from trees and other considerations.

6. Nitrogen Dioxide (NO_2)

6.1 Vertical and Horizontal Probe Placement

6.2 Spacing from Obstructions

6.3 Spacing from Roads

6.4 Spacing from trees and other considerations.

7. Lead(Pb)

7.1 Vertical Placement

7.2 Spacing from Obstructions

7.3 Spacing from Roadways

7.4 Spacing from trees and other considerations.

1. *Introduction*

This appendix contains probe siting criteria to be applied to ambient air quality monitors or monitor probes after the general station location has been selected based on the monitoring objectives and spatial scale of representativeness as discussed in appendix D of this part. Adherence to these siting criteria is necessary to ensure the uniform collection of compatible and comparable air quality data.

The probe siting criteria as discussed below must be followed to the maximum extent possible. It is recognized that there may be situations when the probe siting criteria cannot be followed. If the siting criteria cannot be met, this must be thoroughly documented with a written request for a waiver which describes how and why the siting criteria differs. This documentation should help to avoid later questions about the data. Conditions under which EPA would consider an application for waiver from these siting criteria are discussed in section 10 of this appendix.

The spatial scales of representativeness used in this appendix, i.e., micro, middle, neighborhood, urban, and regional are defined and discussed in appendix D of this part. The pollutant specific probe siting criteria generally apply to all spatial scales except where noted otherwise. Specific siting criteria that are prefaced with a "must" are defined as a requirement and exceptions must be approved through the waiver provisions. However, siting criteria that are prefaced with a "should" are defined as a goal to meet for consistency but are not a requirement.

2. [Reserved]

3. *Sulfur Dioxide (SO_2)*

3.1 Horizontal and Vertical Probe Placement. As with TSP monitoring, the most desirable height for an SO_2 monitor inlet probe is near the breathing height. Various factors enumerated before may require that the inlet probe be elevated. Therefore, the inlet probe must be located 3 to 15 meters above ground level. If the inlet probe is located on the side of a building, then it should be located on the windward side of the building relative to the prevailing winter wind direction. The inlet probe must also be located more than 1 meter vertically or horizontally away from any supporting structure and also away from dirty, dusty areas.

3.2 Spacing from Obstructions. No furnace or incineration flues, or other minor sources of SO_2 should be nearby. The separation distance is dependent on the height of the flues, type of waste or fuel burned, and the quality of the fuel (sulfur content). If the inlet probe is located on a roof or other structure, it must be at least 1 meter from walls, parapets, penthouses, etc.

The inlet probe must be located away from obstacles and buildings. The distance between the obstacles and the inlet probe must be at least twice the height that the obstacle protrudes above the inlet probe. Sampling stations that are located closer to obstacles than this criterion allows should not be classified as a neighborhood scale, since the measurements from such a station would closely represent middle scale stations. Therefore, stations not meeting the criterion should be classified as middle scale. Airflow must also be unrestricted in an arc of at least 270° around the inlet probe, and the predominant wind direction for the season of greatest pollutant concentration potential must be included in the 270° arc. If the probe is located on the side of a building, 180° clearance is required. Additional information on SO_2 probe siting criteria may be found in reference 11.

3.3 Spacing from trees and other considerations. Trees can provide surfaces for SO_2 adsorption and act as an obstruction to normal wind flow patterns. To minimize the possible effects of trees on the measured SO_2 levels, the sampler should be placed at least 20 meters from the drip line of trees. However, in situations where trees could be classified as an obstruction, i.e., the distance between the tree(s) and the sampler is less than twice the height that the tree(s) protrudes above the sampler, the sampler must be placed at least 10 meters from the drip line of the obstructing tree(s).

★ ★ ★ ★ ★ ★

8. *Particulate Matter (PM_{10})*

8.1 Vertical Placement-Although there are limited studies on the PM_{10} concentration gradients around roadways or other ground level sources, References 1, 2, 4, 18 and 19 of this appendix show a distinct variation in the distribution of TSP and Pb levels near roadways. TSP, which is greatly affected by gravity, has large concentration gradients, both horizontal and vertical, immediately adjacent to roads. Lead, being predominately sub-micron in size, behaves more like a gas and exhibits smaller vertical and horizontal gradients than TSP. PM_{10}, being intermediate in size between these two extremes exhibits dispersion properties of both gas and settleable particulates and does show vertical and horizontal gradients.[30] Similar to monitoring for other pollutants, optimal placement of the sampler inlet for PM_{10} monitoring should be at breathing height level. However, practical factors such as prevention of vandalism, security, and safety precautions must also be considered when siting a PM_{10} monitor. Given these considerations, the sampler inlet for microscale PM_{10} monitors must be 2-7 meters above ground level. The lower limit was based on a compromise between ease of servicing the sampler and the desire to avoid re-entrainment from dusty surfaces. The upper limit represents a compromise between the desire to have measurements which are most representative of population exposures and a consideration of the practical factors noted above.

For middle or larger spatial scales, increased diffusion results in vertical concentration gradients that are not as great as for the microscale. Thus, the required height of the air intake for middle or larger scales is 2-15 meters.

8.2 Spacing from Obstructions-If the sampler is located on a roof or other structure, then there must be a minimum of 2 meters separation from walls, parapets, penthouses, etc. No furnace or incineration flues should be nearby. This separation distance from flues is dependent on the height of the flues, type of waste or fuel burned, and quality of the fuel (ash content). In the case of emissions from a chimney resulting from natural gas combustion, as a precautionary measure, the sampler should be placed at least 5 meters from the chimney.

On the other hand, if fuel oil, coal, or solid waste is burned and the stack is sufficiently short so that the plume could reasonably be expected to impact on the sampler intake a significant part of the time, other buildings/locations in the area that are free from these types of sources should be considered for sampling. Trees provide surfaces for particulate desposition and also restrict airflow. Therefore, the sampler should be placed at least 20 meters from the dripline and must be 10 meters from the dripline when the tree(s) acts as an obstruction.

The sampler must also be located away from obstacles such as buildings, so that the distance between obstacles and the sampler is at least twice the height that the obstacle protrudes above the sampler except for street canyon sites. Sampling stations that are located closer to obstacles than this criterion allows should not be classified as neighborhood, urban, or regional scale, since the measurements from such a station would closely represent middle scale stations. Therefore, stations not meeting the criterion should be classified as middle scale.

There must be unrestricted airflow in an arc of at least 270° around the sampler except for street canyon sites. Since the intent of the category (a) site is to measure the maximum concentrations from a road or point source, there must be no significant obstruction between a road or point source and the monitor, even though other spacing from obstruction criteria are met. The predominant direction for the season with the greatest pollutant concentration potential must be included in the 270° arc.

8.3 Spacing from Roads-Since emissions associated with the operation of motor vehicles contribute to urban area particulate matter ambient levels, spacing from roadway criteria are necessary for ensuring national consistency in PM_{10} sampler siting.

The intent is to locate category (a) NAMS sites in areas of highest concentrations whether it be from mobile or multiple stationary sources. If the area is primarily affected by mobile sources and the maximum concentration area(s) is judged to be a traffic corridor or street canyon location, then the monitors should be located near roadways with the highest traffic volume and at separation distances most likely to produce the highest concentrations. For the microscale traffic corridor station, the location must be between 5 and 15 meters from the major roadway. For the microscale street canyon site the location must be between 2 and 10 meters from the roadway. For the middle scale station, a range of acceptable distances from the roadway is shown in Figure 2. This figure also includes separation distances between a roadway and neighborhood or larger scale stations by default. Any station, 2 to 15 meters high, and further back than the middle scale requirements will generally be neighborhood, urban or regional scale. For example, according to Figure 2, if a PM_{10} sampler is primarily influenced by roadway emissions and that sampler is set back 10 meters from a 30,000 ADT road, the station should be classified as a micro scale, if the sampler height is between 2 and 7 meters. If the sampler height is between 7 and 15 meters, the station should be classified as middle scale. If the sample is 20 meters from the same road, it will be classified as middle scale; if 40 meters, neighborhood scale; and if 110 meters, an urban scale.

It is important to note that the separation distances shown in Figure 2 are measured from the edge of the nearest traffic lane of the roadway presumed to have the most influence on the site. In general, this presumption is an oversimplification of the usual urban settings which normally have several streets that impact a given site. The effects of surrounding streets, wind speed, wind direction and topography should be considered along with Figure 2 before a final decision is made on the most appropriate spatial scale assigned to the sampling station.

8.4 Other Considerations. For those areas that are primarily influenced by stationary source emissions as opposed to roadway emissions, guidance in locating these areas may be found in the guideline document Optimum Network Design and Site Exposure Criteria for Particulate Matter.[29]

Stations should not be located in an unpaved area unless there is vegetative ground cover year round, so that the impact of wind blown dusts will be kept to a minimum.

9. *Probe Material and Pollutant Sample Residence Time*

For the reactive gases, SO_2, NO_2, and O_3, special probe material must be used. Studies[20–24] have been conducted to determine the suitability of materials such as polypropylene, polyethylene, polyvinylchloride, tygon, aluminum, brass, stainless steel, copper, pyrex glass and teflon for use as intake sampling lines. Of the above materials, only pyrex glass and teflon have been found to be acceptable for use as intake sampling lines for all the reactive gaseous pollutants. Furthermore, EPA[25] has specified borosilicate glass or FEP teflon as the only acceptable probe materials for delivering test atmospheres in the determination of reference or equivalent methods. Therefore, borosilicate glass, FEP teflon, or their equivalent must be used for existing and new NAMS or SLAMS.

No matter how nonreactive the sampling probe material is initially, after a period of use reactive particulate matter is deposited on the probe walls. Therefore, the time it takes the gas to transfer from the probe inlet to the sampling device is also critical. Ozone in the presence of NO will show significant losses even in the most inert probe material when the residence time exceeds 20 seconds.[26] Other studies[27–28] indicate that a 10-second or less residence time is easily achievable. Therefore, sampling probes for reactive gas monitors at SLAMS or NAMS must have a sample residence time less than 20 seconds.

10. *Waiver Provisions*

It is believed that most sampling probes or monitors can be located so that they meet the requirements of this appendix. New stations with rare exceptions, can be located within the limits of this appendix. However, some existing stations may not meet these requirements and yet still produce useful data for some purposes. EPA will consider a written request from the State Agency to waive one or more siting criteria for some monitoring stations providing that the State can adequately demonstrate the need (purpose) for monitoring or establishing a monitoring station at that location. For establishing a new station, a waiver may be granted only if both of the following criteria are met:

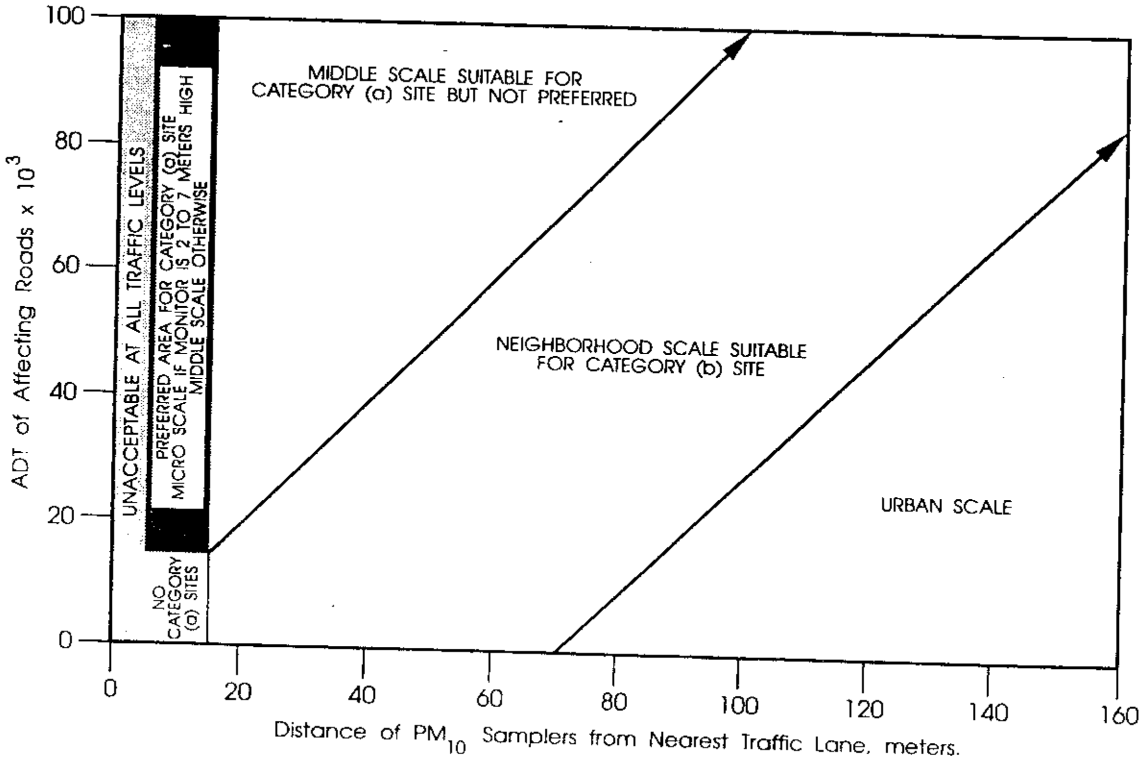
The site can be demonstrated to be as representative of the monitoring area as it would be if the siting criteria were being met.

The monitor or probe cannot reasonably be located so as to meet the siting criteria because of physical constraints (e.g., inability to locate the required type of station the necessary distance from roadways or obstructions).

However, for an existing station, a waiver may be granted if either of the above criteria are met.

Cost benefits, historical trends, and other factors may be

Figure 2. Acceptable Areas for PM_{10} Micro, Middle, Neighborhood, and Urban Samplers Except for Microscale Street Canyon Sites



[20–28] See References at end of this appendix.

used to add support to the above, however, they in themselves, will not be acceptable reasons for granting a waiver. Written requests for waivers must be submitted to the Regional Administrator. For those SLAMS also designated as NAMS, the request will be forwarded to the Administrator.

11. *Discussion and Summary*

Table 5 presents a summary of the requirements for probe-siting criteria with respect to distances and heights. It is apparent from Table 5 that different elevation distances above the ground are shown for the various pollutants. The discussion in the text for each of the pollutants described reasons for elevating the monitor or probe. The differences in the specified range of heights are based on the vertical concentration gradients. For CO, the gradients in the vertical direction are very large for the microscale, so a small range of heights has been used. The upper limit of 15 meters was specified for consistency between pollutants and to allow the use of a single manifold for monitoring more than one pollutant.

Table 5—Summary of Probe Siting Criteria

Pollutant	Scale	Height above ground, meters	Distance from supporting structure, meters		Other spacing criteria
			Vertical	Horizontal[a]	
SO_2....................	All............	3-15	>1	>1	1. Should be >20 meters from the dripline and must be 10 meters from the dripline when the tree(s) act as an obstruction. 2. Distance from inlet probe to obstacle, such as buildings, must be at least twice the height the obstacle protrudes above the inlet probe.[b] 3. Must have unrestricted airflow 270° around the inlet probe, or 180° if probe is on the side of a building. 4. No furnace or incinerator flues should be nearby.[c]
CO....................	Micro.......	3±½	>1	>1	1. Must be >10 meters from street intersection and should be at a midblock location. 2. Must be 2-10 meters from edge of nearest traffic lane. 3. Must have unrestricted airflow 180° around the inlet probe.
	Middle Neighbor-hood	3-15	>1	>1	1. Must have unrestricted airflow 270° around the inlet probe, or 180° if probe is on the side of a building. 2. Spacing from roads varies with traffic (see Table 1).
O_3....................	All............	3-15	>1	>1	1. Should be >20 meters from the dripline and must be 10 meters from the dripline when the tree(s) act as an obstruction. 2. Distance from inlet probe to obstacle, such as buildings, must be at least twice the height the obstacle protrudes above the inlet probe.[b] 3. Must have unrestricted airflow 270° around the inlet probe, or 180° if probe is on the side of a building. 4. Spacing from roads varies with traffic (see Table 2).
NO_2....................	All............	3-15	>1	>1	1. Should be >20 meters from the dripline and must be 10 meters from the dripline when the tree(s) act as an obstruction. 2. Distance from inlet probe to obstacle, such as buildings, must be at least twice the height the obstacle protrudes above the inlet probe.[b] 3. Must have unrestricted airflow 270° around the inlet probe, or 180° if probe is on the side of a building.

Table 5—Summary of Probe Siting Criteria—Continued

Pollutant	Scale	Height above ground, meters	Distance from supporting structure, meters: Vertical	Distance from supporting structure, meters: Horizontal[a]	Other spacing criteria
					4. Spacing from roads varies with traffic (see Table 3).
Pb	Micro	2-7	—	>2	1. Should be >20 meters from the dripline and must be 10 meters from the dripline when the tree(s) act as an obstruction. 2 Distance from sampler to obstacle, such as buildings, must be at least twice the height the obstacle protrudes above the sampler.[b] 3. Must have unrestricted airflow 270° around the sampler except for street canyon sites. 4. No furnace or incineration flues should be nearby.[c] 5. Must be 5 to 15 meters from major roadway.
	Middle, neighbor-hood, urban and regional	2-15	—	>2	1. Should be >20 meters from the dripline and must be 10 meters from the dripline when the tree(s) act as an obstruction. 2. Distance from sampler to obstacle, such as buildings, must be at least twice the height the obstacle protrudes above the sampler.[b] 3. Must have unrestricted airflow 270° around the sampler. 4. No furnace or incineration flues should be nearby.[c] 5. Spacing from roads varies with traffic (see Table 4).
PM_{10}	Micro	2-7	—	>2	1. Should be >20 meters from the dripline and must be 10 meters from the dripline when the tree(s) acts as an obstruction. 2 Distance from sampler to obstacle, such as buildings, must be at least twice the height the obstacle protrudes above the sampler except for street canyon sites.[b] 3. Must have unrestricted airflow 270° around the sampler except for street canyon sites. 4. No furnace or incineration flues should be nearby 5. Spacing from roads varies with traffic (see Figure 2) except for street canyon sites which must be from 2 to 10 meters from the edge of the nearest traffic lane.
	Middle, neighbor-hood urban and regional scale	2-15	—	>2	1. Should be >20 meters from the dripline and must be 10 meters from the dripline when the tree(s) act as an obstruction. 2. Distance from sampler to obstacle, such as buildings, must be at least twice the height the obstacle protrudes above the sampler.[b] 3. Must have unrestricted airflow 270° around the sampler. 4. No furnace or incineration flues should be nearby.[c] 5. Spacing from roads varies with traffic (see Figure 2).

[a] When probe is located on rooftop, this separation distance is in reference to walls, parapets, or penthouses located on the roof.
[b] Sites not meeting this criterion would be classified as middle scale (see text).
[c] Distance is dependent on height of furnace or incineration flues, type of fuel or waste burned, and quality of fuel (sulfur, ash or lead content). This is to avoid undue influences from minor pollutant sources.

12. *References*

1. Bryan, R.J., R.J. Gordon, and H. Menck. Comparison of High Volume Air Filter Samples at Varying Distances from Los Angeles Freeway. University of Southern California, School of Medicine, Los Angeles, CA. (Presented at 66th Annual Meeting of Air Pollution Control Association. Chicago, IL., June 24-28, 1973. APCA 73-158.)

2. Teer, E.H. Atmospheric Lead Concentration Above an Urban Street. Master of Science Thesis, Washington University, St. Louis, MO. January 1971.

3. Bradway, R.M., F.A. Record, and W.E. Belanger. Monitoring and Modeling of Resuspended Roadway Dust Near Urban Arterials. GCA Technology Division, Bedford, MA. (Presented at 1978 Annual Meeting of Transportation Research Board, Washington, DC. January 1978.)

4. Pace, T.G., W.P. Freas, and E.M. Afify. Quantification of Relationship Between Monitor Height and Measured Particulate Levels in Seven U.S. Urban Areas. U.S. Environmental Protection Agency, Research Triangle Park, NC. (Presented at 70th Annual Meeting of Air Pollution Control Association, Toronto, Canada, June 20-24, 1977. APCA 77-13.4.)

5. Harrison, P.R. Considerations for Siting Air Quality Monitors in Urban Areas. City of Chicago, Department of Environmental Control, Chicago, IL. (Presented at 66th Annual Meeting of Air Pollution Control Association, Chicago, IL., June 24-28, 1973. APCA 73-161.)

6. Study of Suspended Particulate Measurements at Varying Heights Above Ground. Texas State Department of Health, Air Control Section, Austin, TX. 1970. p.7.

7. Rodes, C.E. and G.F. Evans. Summary of LACS Integrated Pollutant Data. In: Los Angeles Catalyst Study Symposium. U.S. Environmental Protection Agency, Research Triangle Park, NC. EPA Publication No. EPA-600/4-77-034. June 1977.

8. Lynn, D.A. et. al. National Assessment of the Urban Particulate Problem: Volume 1, National Assessment. GCA Technology Division, Bedford, MA. U.S. Environmental Protection Agency, Research Triangle Park, NC. EPA Publication No. EPA-450/3-75-024. June 1976.

9. Pace, T.G. Impact of Vehicle-Related Particulates on TSP Concentrations and Rationale for Siting Hi-Vols in the Vicinity of Roadways. OAQPS, U.S. Environmental Protection Agency, Research Triangle Park, NC. April 1978.

10. Ludwig, F.L., J.H. Kealoha, and E. Shelar. Selecting Sites for Monitoring Total Suspended Particulates. Stanford Research Institute, Menlo Park, CA. Prepared for U.S. Environmental Protection Agency, Research Triangle Park, NC. EPA Publication No. EPA-450/3-77-018. June 1977, revised December 1977.

11. Ball, R.J. and G.E. Anderson. Optimum Site Exposure Criteria for SO2 Monitoring. The Center for the Environment and Man, Inc., Hartford, CT. Prepared for U.S. Environmental Protection Agency, Research Triangle Park, NC. EPA Publication No. EPA-450/3-77-013. April 1977.

12. Ludwig, F.L. and J.H.S. Kealoha. Selecting Sites for Carbon Monoxide Monitoring. Stanford Research Institute, Menlo Park, CA. Prepared for U.S. Environmental Protection Agency, Research Park,
NC. EPA Publication No. EPA-450/3-75-077. September 1975.

13. Ludwig, F.L. and E. Shelar. Site Selection for the Monitoring of Photochemical Air Pollutants. Stanford Research Institute, Menlo Park, CA. Prepared for U.S. Environmental Protection Agency, Research Triangle Park, NC. EPA Publication No. EPA-450/3-78-013. April 1978.

14. Lead Analysis for Kansas City and Cincinnati, PEDCo Environmental, Inc., Cincinnati, OH. Prepared for U.S. Environmental Protection Agency, Research Triangle Park, NC. EPA Contract No. 66-02-2515, June 1977.

15. Barltrap, D. and C. D. Strelow. Westway Nursery Testing Project. Report to the Greater London Council. August 1976.

16. Daines, R. H., H. Moto, and D. M. Chilko. Atmospheric Lead: Its Relationship to Traffic Volume and Proximity to Highways. Environ. Sci. and Technol., 4:318, 1970.

17. Johnson, D. E., et al. Epidemiologic Study of the Effects of Automobile Traffic on Blood Lead Levels, Southwest Research Institute, Houston, TX. Prepared for U.S. Environmental Protection Agency, Research Triangle Park, NC. EPA-600/1-78-055, August 1978.

18. Air Quality Criteria for Lead. Office of Research and Development, U.S. Environmental Protection Agency, Washington, DC EPA-600/8-77-017. December 1977.

19. Lyman, D. R. The Atmospheric Diffusion of Carbon Monoxide and Lead from an Expressway, Ph.D. Dissertation, University of Cincinnati, Cincinnati, OH. 1972.

20. Wechter, S.G. Preparation of Stable Pollutant Gas Standards Using Treated Aluminum Cylinders. ASTM STP. 598:40-54, 1976.

21. Wohlers, H.C., H. Newstein and D. Daunis. Carbon Monoxide and Sulfur Dioxide Adsorption On and Description From Glass, Plastic and Metal Tubings. J. Air Poll. Con. Assoc. 17:753, 1976.

22. Elfers, L.A. Field Operating Guide for Automated Air Monitoring Equipment. U.S. NTIS. p. 202, 249, 1971.

23. Hughes, E.E. Development of Standard Reference Material for Air Quality Measurement. ISA Transactions, 14:281-291, 1975.

24. Altshuller, A.D. and A.G. Wartburg. The Interaction of Ozone with Plastic and Metallic Materials in a Dynamic Flow System. Intern. Jour. Air and Water Poll., 4:70-78, 1961.

25. CFR Title 40 part 53.22, July 1976.

26. Butcher, S.S. and R.E. Ruff. Effect of Inlet Residence Time on Analysis of Atmospheric Nitrogen Oxides and Ozone, Anal. Chem., 43:1890, 1971.

27. Slowik, A.A. and E.B. Sansone. Diffusion Losses of Sulfur Dioxide in Sampling Manifolds. J. Air. Poll. Con. Assoc., 24:245, 1974.

28. Yamada, V.M. and R.J. Charlson. Proper Sizing of theSampling Inlet Line for a Continuous Air Monitoring Station. Environ. Sci. and Technol., 3:483, 1969.

29. Koch, R.C. and H.E. Rector. Optimum Network Design and Site Exposure Criteria for Particulate Matter, GEOMET Technologies, Inc., Rockville, MD. Prepared for U.S. Environmental Protection Agency, Research Triangle Park, NC. EPA Contract No. 68-02-3584. EPA 450/4-87-009. May 1987.

30. Burton, R.M. and J.C. Suggs. Philadelphia Roadway Study. Environmental Monitoring Systems Laboratory, U.S. Environmental Protection Agency, Research Triangle Park, N.C. EPA-600/4-84-070 September 1984.

[44 FR 27571, May 10, 1979; 44 FR 72592, Dec. 14, 1979, as amended at 46 FR 44170, Sept. 3, 1981; 51 FR 9598, Mar. 19, 1986; 52 FR 24744-24748, July 1, 1987; 52 FR 27286, July 20, 1987]

Excerpts of Ambient Monitoring Guidelines for Prevention of Significant Deterioration (PSD) EPA-450/4-87-007

3 Network Design and Probe Siting Criteria

A source subject to PSD should proceed with designing a PSD monitoring network only after going through the procedure in Appendix A to determine if monitoring data will be required. To fulfill that requirement, a source may use representative air quality data which was discussed in Section 2.4 or monitor. This section presents guidance to be used if an applicant decides to monitor in lieu of using representative air quality data.

3.1 Network Design

The design of a network for criteria and noncriteria pollutants will be affected by many factors, such as topography, climatology, population, and existing emission sources. Therefore, the ultimate design of a network for PSD purposes must be decided on a case-by-case basis by the permit granting authority. Section 3.2 discusses the number and location of monitors for a PSD network. Additional guidance on the general siting of the monitors may be found in references 9-13 which discuss highest concentration stations, isolated point sources, effects of topography, etc. Probe siting criteria for the monitors are discussed in Section 3.3. The guidelines presented here should be followed to the maximum extent practical in developing the final PSD monitoring network.

3.2 Number and Location of Monitors

The number and location of monitoring sites will be determined on a case-by-case basis by the source owner or operator and reviewed by the permit granting authority. Consideration should be given to the effects of existing sources, terrain, meteorological conditions, existence of fugitive or reentrained dusts, averaging time for the pollutant, etc. Generally, the number of monitors will be higher where the expected spatial variability of the pollutant in the area(s) of study is higher.

3.2.1 Preconstruction Phase

Information obtained in the ambient air quality analysis in Appendix A will be used to assist in determining the number and location of monitors for the preconstruction phase. The air quality levels before construction were determined by modeling or in conjunction with monitoring data. The screening procedure (or more refined model) estimates were determined in Appendix A.

The source should first use the screening procedure or refined model estimates to determine the general location(s) for the maximum air quality concentrations from the proposed source or modification. Secondly, the source should determine by modeling techniques the general location(s) for the maximum air quality levels from existing sources. Thirdly, the modeled pollutant contribution of the proposed source or modification should be analyzed in conjunction with the modeled results for existing sources to determine the maximum impact area. Application of these models must be consistent with EPA's "Guideline on Air Quality Models" [14]. This would provide sufficient information for the applicant to place a monitor at (a) the location(s) of the maximum concentration increase expected from the proposed source or modification, (b) the location(s) of the maximum air pollutant concentration from existing sources of emissions, and (c) the location(s) of the maximum impact area, i.e., where the maximum pollutant concentration would hypothetically occur based on the combination effect of existing sources and the proposed new source or modification. In some cases, two or more of these locations may coincide and thereby reduce the number of monitoring stations.

Monitoring should then be conducted in or as close to these areas as possible (also see discussion in Section 3.2.3). Generally, one to four sites would cover most situations in multisource settings. For remote areas in which the permit granting authority has determined that there are no significant existing sources, a minimum number of monitors would be needed, i.e., one or probably two at the most. For new sources, in these remote areas, as opposed to modifications, some concessions will be made on the locations of these monitors. Since the maximum impact from these new sources would be in remote areas, the monitors may be located, based on convenience or accessibility, near the proposed new source rather than near the maximum impact area since the existing air quality would be essentially the same in both areas. However, the maximum impact area is still the preferred location.

When industrial process fugitive particulate emissions are involved, the applicant should locate a monitor at the proposed source site (also see Section 3.2.3). If stack emissions are also involved, a downwind location should also be selected.

★ ★ ★ ★ ★ ★ ★ ★

3.2.2 Postconstruction Phase

As discussed above for preconstruction monitoring, appropriate dispersion modeling techniques are used to estimate the location of the air quality impact of the new source or modification. Monitors should then be placed at (a) the expected area of the maximum concentration from the new source or modification, and (b) the maximum impact area(s), i.e., where the maximum pollutant concentration will occur based on the combined effect of existing sources and the new source or modification. It should be noted that locations for these monitors may be different from those sites for the preconstruction phase due to other new sources or modifications in the area since the preconstruction monitoring.

Generally, two or three sites would be sufficient for most situations in multisource areas. In remote areas where there are no significant existing sources, one or two sites would be sufficient. These sites would be placed at the locations indicated from the model results. The same concerns discussed in Section 3.2.1 regarding industrial process fugitive particulate emissions, fugitive hydrocarbon emissions, and ozone monitoring would also be applicable for the postconstruction phase.

3.2.3. *Special Concerns for Location of Monitors*

For the preconstruction and postconstruction phases, modeling is used to determine the general area where monitors would be located. Some of the modeled locations may be within the confines of the source's boundary. However, monitors should be placed in those locations satisfying the definition of ambient air. Ambient air is defined in 40 CFR 50.1(e) as "that portion of the atmosphere, external to buildings, to which the general public has access." Therefore, if the modeled locations are within an area excluded from ambient air, the monitors would be located downwind at the boundary of that area.

In some cases it is simply not practical to place monitors at the indicated modeled locations. Some examples may include over open bodies of water, on rivers, swamps, cliffs, etc. The source and the permit granting authority should determine on a case-by-case basis alternative locations.

3.3 *Probe Siting Criteria*

The desire for comparability in monitoring data requires adherence to some consistent set of guidelines. Therefore, the probe siting criteria discussed below must be followed to the maximum extent possible to ensure uniform collection of air quality data that are comparable and compatible.

Before proceeding with the discussion of pollutant specific probe siting criteria, it is important to expand on the discussion in Section 3.2 of the location of monitors. In particular, reference is made to two monitoring objectives.

Case 1: Locating monitors to determine the maximum concentration from the proposed source and/or existing sources.

Case 2: Locating monitors to determine where the combined impact of the proposed source and existing sources would be expected to exhibit the highest concentrations.

For Case 1, the driving force for locating the siting area of the monitor as well as the specific location of the probe or instrument shelter is the objective of measuring the maximum impact from the proposed source. Two Case 1 examples are given. Consider the first situation in which a proposed source would be emitting pollutants from an elevated stack. Under these circumstances, sufficient mixing generally occurs during the transport of the emissions from the stack to the ground resulting in small vertical gradients near ground level, thus, a wide range of probe heights, 3-15 meters for gases and 2-15 meters for particulates is acceptable. For the same objective (maximum concentration from proposed source), consider the second example in which pollutants would be emitted from a ground level source. In this case, the concentration gradient near the ground can be large, thereby requiring a much tighter range of acceptable probe heights. For ground level sources emitting pollutants with steep vertical concentration gradients, efforts should be made to locate the inlet probe for gaseous pollutant monitors as close to 3 meters (a reasonable practical representation of the breathing zone) as possible and for particulate monitors using the hi-volume sampler 2 to 7 meters above ground level. The rationale for the 3 meters is that for gaseous pollutant measurements, the inlet probe can be adjusted for various heights even though the monitor is located in a building or trailer. On the contrary, the 2-3 meter height for the hi-volume sampler placement is not practical in certain areas. The 7 meter height allows for placement on a one story building and is reasonably close to representing the breathing zone.

Turn now to the second monitoring objective, Case 2, which is locating monitors to determine the maximum impact area taking into consideration the proposed source as well as existing sources. The critical element to keep in mind in locating a monitor to satisfy this objective is that the intent is to maximize the combined effect. Thus, in one circumstance, the existing source might contribute the largest impact. The importance of the above discussion to the topic of probe siting criteria is that in attempting to locate a monitor to achieve this objective, the placement of the probe or instrument shelter can vary depending upon which source is the predominant influence on the maximum impact area. As an extreme example, consider the situation where a proposed elevated source would emit CO into an urban area and have maximum combined CO impact coincident to an area adjacent to a heavily traveled traffic corridor. It is known that traffic along corridors emit CO in fairly steep concentration gradients so the placement of the probe to measure the areas of highest CO concentration can vary significantly with probe height as well as distance from the corridor. In this example, the traffic corridor has the major influence on the combined impact and therefore controls the probe placement. As noted in the CO probe siting criteria in Section 3.3.3 as well as Appendix E of the May 10, 1979 Federal Register promulgation of the Ambient Air Monitoring Regulations [7] and revised and updated on March 19, 1986 [15], the required probe height in such microscale cases is given as 3 ± ½ meters while the distance of the probe from the roadway would be between 2 and 10 meters.

As another example, consider the case where the same proposed CO source would emit CO at elevated heights and have a combined maximum CO impact in an urban area that is only slightly affected by CO emissions from a roadway. The combined impact area in this case is far enough away from the two sources to provide adequate mixing and only small vertical concentration gradients at the impact area. In this case, the acceptable probe height would be in the range of 3-15 meters.

It is recognized that there may be other situations occurring which prevent the probe siting criteria from being followed. If so, the differences must be thoroughly documented. This documentation should minimize future questions about the data.

★ ★ ★ ★ ★ ★ ★ ★

3.3.2.1. Vertical Placement

Although there are limited studies on the PM_{10} concentration gradients around roadways or other ground level sources, references 16, 17, 19, 25, and 26 show a distinct variation in the distribution of TSP and Pb levels near roadways. TSP, which is greatly affected by gravity, has large concentration gradients, both horizontal and vertical, immediately adjacent to roads. Pb, being predominantly submicron in size, behaves more like a gas and does not exhibit steep vertical and horizontal gradients as does TSP. PM_{10}, being intermediate in size between these two extremes exhibits dispersion properties of both gas and settleable particulates and does show vertical and horizontal gradients [27]. Similar to monitoring for other pollutants, optimal placement of the sampler inlet for PM_{10} monitoring should be at breathing height level. However, practical factors such as prevention of vandalism, security, and safety precautions must also be considered when siting a PM_{10} monitor. Given these considerations, the sampler inlet for ground level source monitoring must be 2-7 meters above ground level. For PM_{10} samplers, the acceptable range for monitoring emissions from elevated sources is 2-15 meters above ground level.

Review Exercise

Now that you've completed the assignment for Lesson 7, please answer the following questions to determine whether or not you are mastering the material.

1. Which of the following is a (are) basic monitoring objective(s) of a SLAMS network?

   a. determination of the highest air pollutant concentrations that are expected to occur in the area covered by the network

   b. determination of representative air pollutant concentrations in areas of high population density

   c. determination of the impact on air pollution levels of significant sources or source categories

   d. determination of general background air pollutant concentration levels

   e. all of the above

2. True or False? The number of monitoring stations required for a SLAMS network is specified in Appendix D of 40 CFR 58.

Match each of the following SLAMS monitoring objectives with its appropriate type of monitoring site. (Questions 3-6)

3. determination of the highest air pollutant concentrations that are expected to occur in the area covered by the network	a. neighborhood and regional
4. determination of representative air pollutant concentrations in areas of high population density	b. neighborhood and urban
5. determination of the impact on air pollution levels of significant sources or source categories	c. micro, middle, and neighborhood
6. determination of general background air pollutant concentration levels	d. micro, middle, neighborhood, and urban

7. True or False? The primary monitoring objective of NAMS is to monitor in areas where pollutant concentrations and population exposure are expected to be the highest consistent with the averaging times of the National Ambient Air Quality Standards.

8. Which of the following is a (are) NAMS category(ies)?

   a. monitoring stations located in areas of expected maximum pollutant concentrations

   b. monitoring stations located in areas of combined poor air quality and high population density

   c. both a and b, above

   d. none of the above

9. Which of the following is a (are) primary use(s) of NAMS data?

   a. analyzing national policy and trends

   b. reporting air quality information concerning major metropolitan areas to the public

   c. both a and b, above

   d. none of the above

Match each of the following urban areas with its required number of PM_{10} NAMS. (Questions 10-15)

10. Population: greater than 1,000,000; PM_{10} concentrations exceeding the PM_{10} NAAQS by 20 percent or more	a. 6 to 10
11. Population: 500,000 - 1,000,000; PM_{10} concentrations greater than 80 percent of the PM_{10} NAAQS	b. 0
12. Population: 100,000 - 250,000 PM_{10} concentrations less than 80 percent of PM_{10} NAAQS	c. 2 to 4
13. Population: 500,000 - 1,000,000; PM_{10} concentrations exceeding the PM_{10} NAAQS by 20 percent or more	d. 4 to 8
14. Population: 250,000 - 500,000; PM_{10} concentrations greater than 80 percent of the PM_{10} NAAQS	e. 1 to 2
15. Population: greater than 1,000,000; PM_{10} concentrations less than 80 percent of the PM_{10} NAAQS	

Match each of the following urban areas with its required number of SO_2 NAMS. (Questions 16-21)

16. Population: 100,000 - 500,000; SO_2 concentrations less than 60 percent of the SO_2 primary NAAQS or 100 percent of the SO_2 secondary NAAQS	a. 0
17. Population: 50,000 - 100,000; SO_2 concentrations exceeding the SO_2 primary NAAQS	b. 1 to 2
18. Population: 100,000 - 500,000; SO_2 concentrations exceeding the SO_2 primary NAAQS	c. 2 to 4
19. Population: greater than 500,000; SO_2 concentrations exceeding the SO_2 primary NAAQS	d. 4 to 6
20. Population: 50,000 - 100,000; SO_2 concentrations less than 60 percent of the SO_2 primary NAAQS or 100 percent of the SO_2 secondary NAAQS	e. 0 to 2
21. Population: 50,000 - 100,000; SO_2 concentrations exceeding 60 percent of the SO_2 primary NAAQS or 100 percent of the SO_2 secondary NAAQS but not exceeding the SO_2 primary NAAQS	f. 6 to 8

22. True or False? Generally, the worst air quality in an urban area should be used as the basis for determining the required number of PM_{10} and SO_2 NAMS for the urban area.

23. True or False? PM_{10} and SO_2 NAMS are always required to be neighborhood scale monitoring stations.

Select the PM_{10} SLAMS/NAMS siting criterion specified in Appendix E of 40 CFR 58 for each of the following parameters. (Questions 24-27)

24. Height range of PM_{10} sampler's air intake above ground-level for all monitoring scales except microscale (meters):

    a. 2 to 10

    b. 3 to 10

    c. 2 to 15

    d. 3 to 15

25. Minimum separation distance from walls, parapets, and penthouses for a roof-located PM_{10} sampler (meters):

    a. 1

    b. 2

    c. 4

    d. 10

26. PM_{10} sampler's minimum separation distance from trees that act as obstructions (meters):

    a. 2

    b. 5

    c. 10

    d. 20

27. Arc of unrestricted air flow around PM_{10} sampler, except for street canyon sites (degrees):

    a. 90

    b. 180

    c. 270

    d. 360

28. Appendix E of 40 CFR 58 requires that a non-street canyon PM_{10} sampler be located away from obstacles such as buildings, so that the distance between an obstacle and the sampler is at least ________ times the height that the obstacle protrudes above the sampler.

    a. 2

    b. 4

    c. 5

    d. 10

29. Appendix E of 40 CFR 58 requires that PM_{10} neighborhood scale NAMS be located greater than ________ meter(s) from the edge of the nearest traffic lane of roadways.

    a. 1

    b. 3

    c. 5

    d. 15

30. For microscale traffic corridor stations, Appendix E of 40 CFR 58 requires that PM_{10} NAMS be located between ________ meters from the edge of the nearest traffic lane of roadways.

    a. 1 and 5

    b. 5 and 10

    c. 5 and 15

    d. 15 and 25

31. True or False? Appendix E of 40 CFR 58 recommends that PM_{10} samplers should not be located in an unpaved area unless there is year-round vegetative ground cover.

Select the SO_2 SLAMS/NAMS siting criterion specified in Appendix E of 40 CFR 58 for each of the following parameters. (Questions 32-38)

32. Height range of SO_2 monitor's inlet probe above ground level (meters):

    a. 2 to 10

    b. 3 to 10

    c. 2 to 15

    d. 3 to 15

33. Minimum horizontal separation distance of SO_2 monitor's inlet probe from its supporting structure (meters):

    a. 0.5

    b. 1

    c. 2

    d. 5

34. Minimum vertical separation distance of SO_2 monitor's inlet probe from its supporting structure (meters):

    a. 0.5

    b. 1

    c. 2

    d. 5

35. Minimum separation distance from walls, parapets, and penthouses for a roof-located SO_2 monitor inlet probe (meters):

    a. 0.5

    b. 1

    c. 2

    d. 5

36. SO_2 monitor inlet probe's minimum separation distance from trees that act as obstructions (meters):

    a. 2

    b. 5

    c. 10

    d. 20

37. Arc of unrestricted air flow for SO_2 monitor inlet probes that are *not* located on sides of buildings (degrees):

    a. 90

    b. 180

    c. 270

    d. 360

38. Arc of unrestricted air flow for SO_2 monitor inlet probes that are located on sides of buildings (degrees):

    a. 45

    b. 90

    c. 135

    d. 180

39. Appendix E of 40 CFR 58 requires that the inlet probe of an SO_2 monitor be located away from obstacles such as buildings, so that the distance between an obstacle and the probe is at least __________ times the height that the obstacle protrudes above the probe.

    a. 2

    b. 4

    c. 5

    d. 10

40. True or False? Appendix E of 40 CFR 58 requires that intake sampling lines for existing and new SO_2 SLAMS/NAMS be constructed of borosilicate glass, FEP teflon, or their equivalent.

41. Appendix E of 40 CFR 58 requires that sampling probes at SO_2 SLAMS/NAMS have a sample residence time of less than __________ seconds.

    a. 5

    b. 10

    c. 15

    d. 20

42. True or False? If the probe-siting criteria specified in Apendix E of 40 CFR 58 cannot be met, a written request for a waiver must be submitted to EPA.

43. In establishing a new SLAMS/NAMS, which of the following conditions must be met in order to obtain a waiver from the monitor siting criteria specified in Appendix E of 40 CFR 58?

    a. The site can be demonstrated to be as representative of the monitoring area as it would be if the siting criteria were being met.

    b. The monitor or probe cannot reasonably be located so as to meet the siting criteria.

    c. both a and b, above

    d. either a or b, above

44. For an existing monitoring station, which of the following conditions must be met in order to obtain a waiver from the monitor siting criteria specified in Appendix E of 40 CFR 58?

    a. The site can be demonstrated to be as representative of the monitoring area as it would be if the siting criteria were being met.

    b. The monitor or probe cannot reasonably be located so as to meet the siting criteria.

    c. both a and b, above

    d. either a or b, above

45. For preconstruction PSD ambient air quality monitoring, monitors should be sited at which of the following locations?

    a. area(s) of the maximum air pollutant concentration increase expected from the proposed source or modification

    b. area(s) of the maximum air pollutant concentration resulting from existing sources of emissions

    c. area(s) where the maximum air pollutant concentration would hypothetically occur based on the combined effect of existing sources and the proposed new source or modification

    d. all of the above

46. For postconstruction PSD ambient air quality monitoring, monitors should be sited at which of the following locations?

    a. expected area of the maximum air pollutant concentration resulting from the new source or modification

    b. area(s) where the maximum pollutant concentration will occur based on the combined effect of existing sources and the new source or modification

    c. area(s) of the maximum air pollutant concentration resulting from existing sources of emissions

    d. all of the above

    e. a and b, above

47. For preconstruction PSD ambient air quality monitoring in a multisource setting, ________ to ________ monitoring sites will be sufficient for most situations.

    a. 1, 3

    b. 1, 4

    c. 2, 5

    d. 2, 6

48. For postconstruction PSD ambient air quality monitoring in a multisource setting, ________ or ________ monitoring sites will be sufficient for most situations.

    a. 1, 2

    b. 2, 3

    c. 3, 4

    d. 4, 5

49. For preconstruction or postconstruction PSD ambient air quality monitoring in a remote area, ________ or ________ monitoring sites will be sufficient for most situations.

    a. 1, 2

    b. 2, 3

    c. 3, 4

    d. 4, 5

50. True or False? Ambient air is defined in 40 CFR 50 as "that portion of the atmosphere, external to buildings, to which the general public has access".

51. True or False? PSD ambient air quality monitors should be placed in locations which satisfy the definition of ambient air.

52. For PSD purposes, when monitoring PM_{10} concentrations resulting from a ground-level source, a PM_{10} sampler's air intake should be located ________ to ________ meters above ground level.

    a. 2, 7

    b. 2, 10

    c. 2, 15

    d. 3, 15

53. For PSD purposes, when monitoring SO_2 concentrations resulting from a ground-level source, an SO_2 monitor's inlet probe should be located as close as possible to ________ meter(s) above ground level.

    a. 1

    b. 3

    c. 10

    d. 15

47. b 7-21

48. b 7-21

49. a 7-21

50. True 7-22

51. True 7-22

52. a 7-23

53. b 7-22